DIVERSITY AND PHENOLOGY OF TUMBLING FLOWER BEETLES (COLEOPTERA: MORDELLIDAE) CAPTURED IN A MALAISE TRAP[1]

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ABSTRACT: Adult mordellid beetles were monitored at Brackenridge Field Laboratory in Austin, Texas from January 1990 through December 1990 using a Malaise trap. A total of 754 specimens representing 35 species (17% of the North American fauna) and one subspecies were taken in this study. Twenty-eight of the species and one subspecies are recorded for the first time from Texas. Specimens were collected as early as March 13-19 and as late as November 27-December 3. Up to 19 species, nearly 10% of the mordellid fauna of North American north of Mexico, were collected in a single week. However, 19 (52%) of the taxa reported in this study were represented by five or fewer specimens indicating that most species were relatively rare. The seasonal flight pattern indicated a unimodal flight activity pattern for the family and also for most species.

The Brackenridge Field Laboratory (BFL). located in Austin, Texas, is operated by the University of Texas at Austin and consists of approximately 50 hectares (80 acres) of land which has been used for a variety of purposes during its recent history. For the past 25 years the land comprising BFL has been a preserve and field laboratory used by researchers and students for various ecological and behavioral studies, e.g., Porter and Savignano (1990). BFL, with its juxtaposition of relatively undisturbed and disturbed areas presents an interesting mosaic of plant species available to various herbivores, such as tumbling flower beetles (Mordellidae). Ongoing studies of the diversity of insect species present at BFL are being conducted by researchers there. A goal of these studies is a more complete knowledge of the entire insect community at a single site in the ecologically rich central Texas area. This study of mordellid beetles complements extensive surveys of other taxa, such as digger wasps (Sphecidae), moths, robber flies (Asilidae), bees, ants, leaf-footed bugs and Odonata. This survey also intends to spur interest in other researchers so that comparisons of similar communities in different ecoregions and biotic provinces can be made. An ancillary goal of this study is to provide researchers in central Texas with an indication of groups of particular ecological concern. For instance, the rich assemblage of mordellid beetles brought to light during this study could be the impetus for additional work of general ecological interest in addressing questions of competition, niche sep-

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aration, adaptation, and other interspecific interactions. The amazing diversity of 30 species in the single genus *Mordellistena* at one site should pique research interest in this group. The family Mordellidae was chosen for particular study because it is easily recognized, relatively diverse but not overwhelming in numbers, poorly documented from the area, and species can be recognized by the senior author. This study summarizes data on Mordellidae from a Malaise trap operated at BFL to determine the species present, the phenology and to provide baseline data on this family for future comparisons to similar data from other locations and habitats.

MATERIALS AND METHODS

Location. BFL is bordered on the south by Town Lake (formed by a dam on the Colorado River), on the north by a road and golf course, and by housing developments on the east and west. The land south of Town Lake where it borders with BFL is sparsely covered with houses with intervening areas of more or less natural assemblages of plants dominated by Ashe juniper *(Juniperus ashei* Buchholz) and several species of oak *(Quercus* spp. especially live oak, *Q. virginiana* Miller and Spanish oak, *Q. texana* Buckley). A possible corridor of colonization connects BFL with large tracts of land on the Edward's Plateau of the Texas Hill Country but is more isolated from the blackland prairie and post oak savannah to the east by the highly urbanized portion of Austin. BFL is a particularly interesting site for the study of geographical insect distribution because of its location on the border of these significant biotic provinces (Blair 1950).

Of the 50 hectares approximately 40 are in a natural or nearly natural state. The four most apparent community types are: dry uplands (29 ha or 58%), riparian floodplain (11 ha or 22%), disturbed old fields (8 ha or 16%) and managed grasslands (2 ha or 4%). Other habitats with distinctive communities include rocky outcrops, spring seeps, lake margins, and lentic aquatic. In general, the plant communities of BFL are diverse with over 378 species having been collected on the tract (Gary Baird, personal communication). Dominant and apparent trees characteristic of the riparian floodplain include pecan *(Carya illinoensis* [Wangenheim] K. Koch), cottonwood *(Populus deltoides* Marshall), and large hackberry trees *(Celtis laevigata* Willdenow). The drier uplands, in contrast, are dominated by Ashe juniper, live oak *(Quercus virginiana* Mill.), cedar elm *(Ulmus crassifolia* Nuttall), and exotic species of privet *(Ligustrum* spp.). The grasslands of BFL have diverse assemblages of grasses including, among others, little bluestem *(Schizachyrium scoparium* [Michaux] Nash), side-oats grama *(Bouteloua curtipendula* [Michaux] Torrey), Bermuda grass *(Cynodon dactylon* L.), and King Ranch bluestem *(Bothriochloa ishaemum* L.) A few of the disturbed sites around BHL are plowed yearly and used for plantings of *Phlox drummondii* Hooker, sunflowers (*Helianthus annuus* L.). and cotton *(Gossypium* sp.).

Trapping. We used a Malaise trap of the Townes design (Townes 1972) with darkened lower panels and a mesh of approximately 20 X 24 strands per inch. The trap was operated continuously at the same location for the duration of the study. The insects were collected into alcohol at intervals of approximately one week from January 1990 to the end of December 1990. A few weekly samples were lost because the trap was damaged by wind or the trap collecting head was broken. Specific trapping intervals which yielded mordellids were: March 13-19, March 20-26, March 27-April 2, April 2-9, April 9-16, April 16-25, April 26-30, May 1-7, May 8-14, May 15-21, May 22-28, May 29-June 4, June 5-11, June 12-18, June 19-25, June 26-July 2, July 3-9, July 10-16, July 17-23, July 24-30, July 31-August 6, August 7-13, August 22-28, August 28-September 3, September 4-10, September 11-17, September 18-24, September 20-26, and November 27-December 3. Intervals not yielding mordellids are noted by zeroes in Figs. 1 & 2.

The trap was placed across a path in rather dense woodland which separated two small meadows. The path was suspected to serve as a flyway between the meadows and was selected to concentrate and intercept insects in this area. The trap was located near BFL exclosure 5 at the upstream margin of the riparian woodland and was flanked by a small man-made pond of approximately 25 m^2 in surface area. The trap was beneath the canopy of pecan and hackberry trees and was positioned such that it was never in direct sunlight.

Mordellid specimens were sorted from the bulk trap samples and stored in 70% ethanol before being air dried and mounted. Specimens were identified primarily using Liljeblad (1945) supplemented with Ray (1936, 1944, 1946a, 1946b, 1946c, 1947), Khalaf (1971), and Jackman (1991). New state records were determined using Bright (1986) and Jackman (1991). Specimens collected during this study were deposited in the collection at the University of Texas in Austin and in the collection of the senior author.

RESULTS

Diversity. A total of 754 specimens representing 35 species and one subspecies were taken in this study and all of them were assigned to described species. The most abundant taxa collected were *Mordellistena convicta* LeConte (111 specimens), *M. andreae ancilla* LeConte (99 specimens), *M. blatchleyi* Liljeblad (66 specimens), *M. splendens* Smith (64 specimens), *Paramordellaria carinata* (Smith) (64 specimens), *M. hebraica* LeConte *(*51 specimens*), M. pustulata* (Melsheimer) (52 specimens) and *M. andreae ustu-*

lata LeConte (46 specimens). These 8 taxa were represented by 553 specimens or 73% of the total specimens. Species that were represented by only a single specimen were: *Mordellistena ferruginoides* (Smith), *M. infima* LeConte, *M. lecontei* Ermisch, *M. masoni* Liljeblad, *M. nubila* (LeConte), *M. rubrifascia* Liljeblad and *M. vapida* LeConte. Estimates of diversity using the chart of Southwood (1978) William's alpha statistic used as an estimate of diversity, was approximately 8 (± 8% SE).

Phenology. Specimens were collected as early as March 13-19 and as late as November 27-December 3. During the week of May 15-21, 101 specimens were captured which represents 13% of the total captured in the study. There were 19 species represented during that week which was 53% of the species captured throughout this study or almost 10% of the entire mordellid fauna from North America north of Mexico.

Specimens taken from May 1 to June 4 represented 45% of the specimens and 69% of the species collected in this study. Specimens taken from April 9 to July 2 represented 89% of the specimens and 94% of the species collected

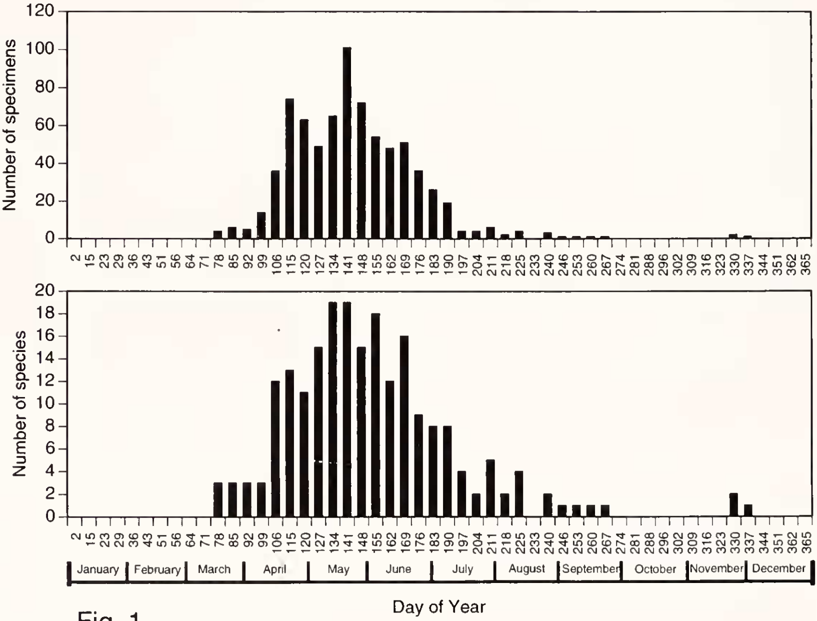

Fig. 1

Figure 1. Seasonal pattern of number of specimens and number of species of adult Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

in this study. Both number of specimens and number of species have basically a single peak during the year (Fig. 1) with only a few species collected in the fall.

Single Species Example. Trap data for *Mordellistena andreae* were selected as an example of the phenology of a single species because it was well represented in the samples and to detect a possible difference in chronology between the two subspecies. A visual comparison of the chronology of trapped adults of these two subspecies of *Mordellistena andreae* was prepared (Fig. 2). The date ranges of the adults of these two subspecies coincided closely providing little evidence of temporal separation. There is a slight tendency for *ustulata* to be later in the season with the midpoint of adult catch about 2 weeks later than that for *ancilla.* This variation in chronology of trapped adults may be partly due to sample size (99 vs. 46) or subspecies assignment. Specimens that were difficult to assign to subspecies were assigned to *ancilla.*

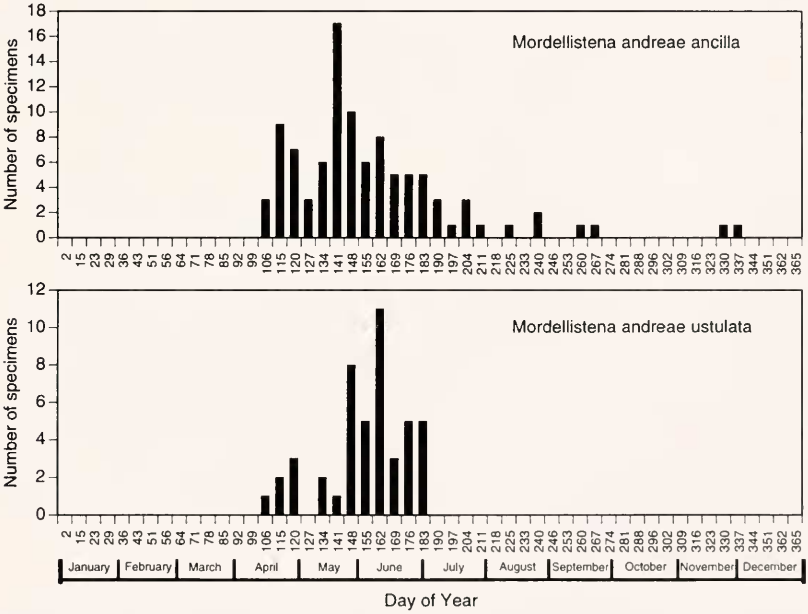

Fig. 2

Figure 2. Seasonal pattern of adult *Mordellistena andreae ancilla* and *M. andrease ustulata* collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

Cumulative Catch. Mordellids were very seasonal but the accumulation of species during the year was gradual during the entire flight activity season (Fig. 3). This accumulation of species changed more rapidly for the weeks beginning on April 16 and June 18 than any other time of the season. These two periods showed an increase of newly encountered species near the beginning of the main flight activity period and the other near the end of the major flight activity period.

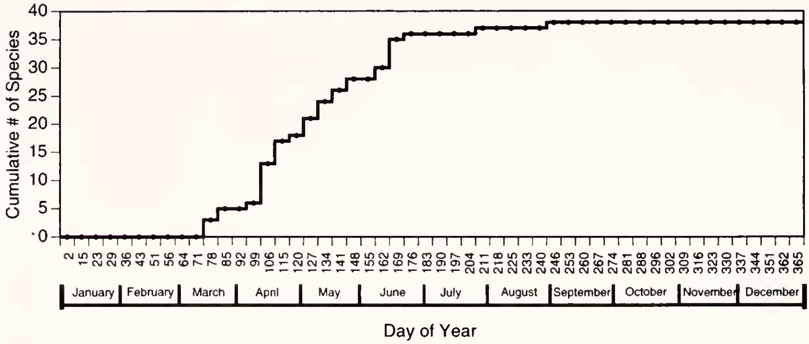

Fig. 3

Figure 3. Cumulative number of species of Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

Phenology of Each Species. A summary of the flight times for each species (Fig. 4) indicates that there are species differences in phenology. Note that the line in Fig. 4 suggests the continual presence by connecting the first and last date that the species was collected. Because there was a single flight activity peak pattern for the family (Fig. 1), we can judge that mordellids are probably univoltine and thus the solid flight activity line implying continual presence of a given species may well be valid. Also note that the common species *Mordellistena andreae* has a broad flight activity period as does the rarer *Mordellistena pauxilla. Mordellistena convicta,* however, is abundant but was recorded from a narrower time period.

Specimens for Each Species.. A frequency distribution of specimens by species is provided in Figure 5. The situation that a few species are abundant and many species are "rare" is apparent. Moreover, 19 of the 36 taxa (52%) collected during this study were represented by 5 or fewer specimens.

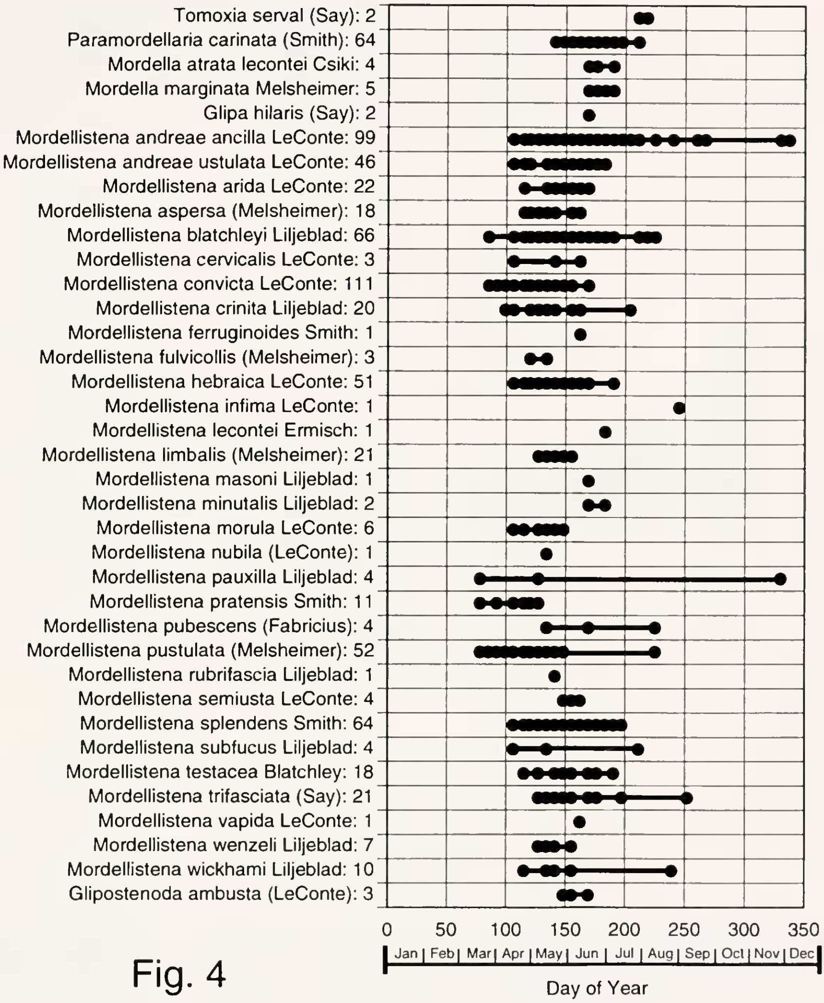

Fig. 4

Figure 4. Seasonal pattern of each species of Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990. Number of individuals trapped after each species name. Lines between circles indicate expected occurrence.

Regression of Species and Specimens. Despite the rarity of many species, as indicated by Fig. 5, the greatest diversity of species occurred when the total number of all mordellid specimens was high (Fig. 6). Even though several species were very abundant in some trapping periods, those same trapping periods yielded the greatest number of species.

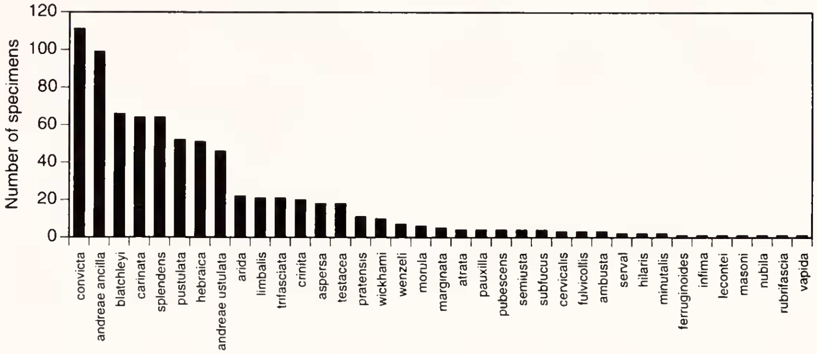

Fig. 5

Figure 5. Frequency distribution of the number of species by number of specimens of Mordellidae collected in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

DISCUSSION

Several striking observations were made in this study. The number of species collected at a single location was surprisingly high. The North American fauna of Mordellidae consists of just over 200 species and subspecies (Bright 1986) which means that over 17% of the fauna was taken by our single Malaise trap at one location. Some species that would be considered to be the most abundant in sweep net samples or collections made on flowers, e.g., *Mordella marginata, M. atrata* and *Mordellistena cervicalis,* were represented in low numbers in our sample. The high number of specimens of some rather uncommon species, e.g., *Mordellistena crinita,* was equally surprising. The characteristics of the Malaise trap sampling method or perhaps the trap placement seem to favor some of the little known species and disfavor some of the species that are common on flowers and in sweep net samples.

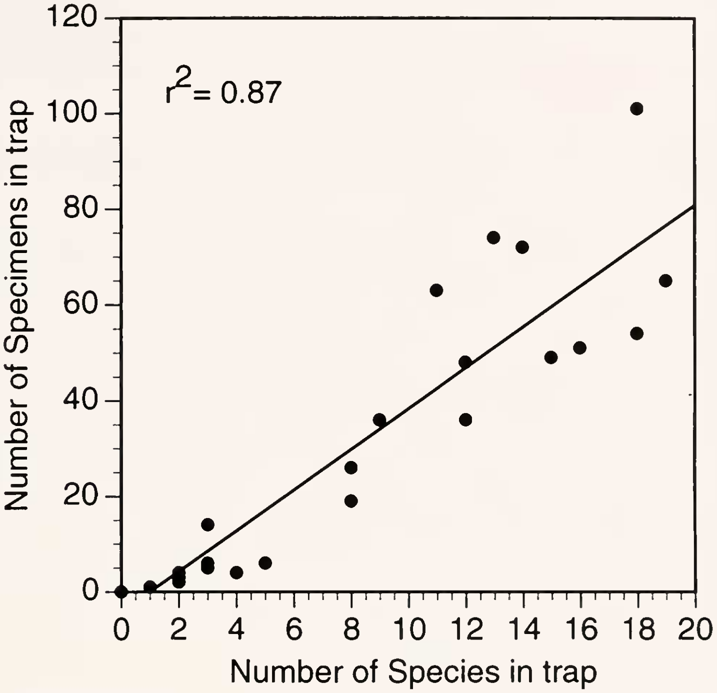

Fig. 6

Figure 6. Relationship between the number of mordellid specimens trapped per week and the number of Mordellid species trapped per week in a Malaise trap at Brackenridge Field Laboratory in Austin, Texas from January 1 through December 31, 1990.

Activity periods of species were generally more elongated than expected from general collecting experience. It was especially interesting to find specimens as late as December. The March collected specimens were not surprising because field experience suggests that mordellids are active early in the season. Some species seem to have a more pronounced and limited activity period while others seem to be active over much of the year.

The single activity peak of adult mordellids as shown in this study contrasts with the Syrphidae which have a bimodal graph of this sort with a peak in May and another smaller one in September-October (C. R. Nelson, unpublished data). The bimodal peak for the syrphids apparently corresponds to the spring and fall flowering seasons. We expect that mordellids are probably pollen feeders and that the unimodal adult peak does not allow them to fully utilize the fall pollen sources. Mordellids as a family may be cuing on a single or a few factors relating to springtime weather which results in unimodal distribution of abundance and diversity. An alternative explanation may be that the larval biology of mordellids dictates spring adult activity. Where known, mordellids are borers in herbaceous stems, fungi and decaying wood (Liljeblad 1945, Lawrence 1991). Oviposition in stems during the fall may not allow sufficient time or provide sufficient nutrients for development before the onset of difficult winter conditions, when growth would be slowed.

We present the first published records for the following species in Texas: *Tomoxia serval* (Say); *Mordellistena andreae ancilla* LeConte; *M. arida* LeConte; *M. aspersa* (Melsheimer), *M. blatchleyi* Liljeblad; *M. cervicalis* LeConte; *M. convicta* LeConte; *M. ferruginoides* Smith; *M. fulvicollis* (Melsheimer); *M. hebraica* LeConte; *M. infima* LeConte; *M. lecontei* Ermisch (= *ruficeps* LeConte); *M. limbalis* (Melsheimer); *M. masoni* Liljeblad; *M. minutalis* Liljeblad; *M. morula* LeConte; *M. nubila (*LeConte); *M. pauxilla* Liljeblad; *M. pratensis* Smith; *M. rubrifascia* Liljeblad; *M. splendens* Smith; *M. subfucus* Liljeblad; *M. testacea* Blatchley; *M. trifasciata* (Say); *M. vapida* LeConte; *M. wenzeli* Liljeblad; *M. wickhami* Liljeblad; and *Glipostenoda ambusta (*LeConte*)*. This seemingly large number of new state records is possible because of the little published research on mordellid species since Liljeblad (1945). Based on experience of the senior author there are specimens in other collections that substantiate most of these records.

CONCLUSIONS

Malaise traps are an excellent means to survey mordellid beetle diversity, probably because they are agile fliers. The number of species collected at a single location in a single trap was surprisingly high, representing over 17% of the fauna of North America north of Mexico. The characteristics of the Malaise trap sampling method or perhaps the particular location seem to favor some of the little known species and disfavor some of the species that are commonly taken on flowers using a sweep net.

An activity peak of adult mordellids was observed that suggests that mordellid activity is cued by springtime weather factors. The low numbers of adults collected in the fall may be limited by larval biology as borers in herbaceous stems, fungi and decaying wood. Flight times of species was generally more elongated than expected from field collected experiences although this pattern varied by species. We hope this study of mordellid diversity will encourage others to address questions of life history adaptations and general ecological interest using these unique beetles.

ACKNOWLEDGMENTS

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